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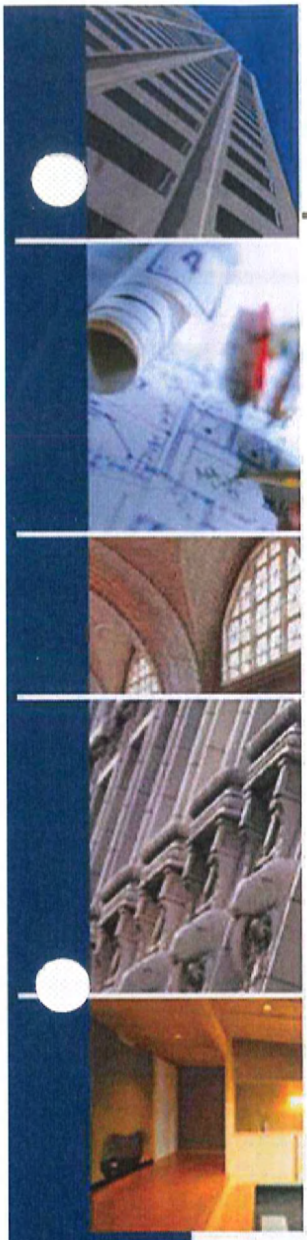
Pollard School Boiler Design RFQ
Contract ID #13PFC-101D



ENERGY AUDIT
REPORT

Town of Needham
Department of Public Facilities
1471 Highland Avenue
Needham, Massachusetts 02492
Kate Fitzpatrick

ENERGY AUDIT REPORT

of

POLLARD MIDDLE SCHOOL
200 Harris Avenue
Needham, Massachusetts 02492

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EMG
DECISION INTELLIGENCE
25th ANNIVERSARY

Includes only selected pages only for reference with Pollard School Boiler Design RFQ

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2. EXECUTIVE SUMMARY

The purpose of this Energy Audit is to provide Pollard Middle School with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

The Pollard Middle School was originally built in 1960 followed by a renovation/expansion in 1992. The portable section of the school was installed in 1999. The existing school building contains a total of 153,355Sqft. The older section of the facility consists of a single story while the new renovated section consists of two floors. During the 1992 renovations all the HVAC system along with lighting and windows were replaced. The old steam heat was replaced with forced hot water system along with two boiler rooms containing a total of four boilers.

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

EMG has uncovered a number of energy saving recommendation for the for the facility that it believes would save a considerable amount of energy annually.

High Priority ECM's:

- Install high efficiency condensing boilers
- Upgrade rooftop condensing units
- Upgrade water heater
- Upgrade lighting and install automatic controls

Major ECM's for consideration:

- Upgrade motors; install VFD for boiler room pumps
- Install demand controlled ventilation (DCV) controls for air handlers

Summary of Existing Energy Performance

Building's EPA Energy Performance Rating[1]	36
Building's Annual Energy Consumption	10,783,063 kBtu
Total Annual Energy Costs	$298,058

EMG has identified 7 Energy Conservation Measures (ECMs) for this property. The savings for each measure are calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Energy Conservation Measures

Item	Estimate
Total Projected Initial ECM Investment	$594,345 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$45,815 *(In Current Dollars)*
Net Effective ECM Payback	12.97 Years
Estimated Annual Energy Savings	22.39%
Estimated Annual Cost Savings	15.11%

List of Recommended Energy Conservation Measures For Pollard Middle School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Total Annual Energy Savings	Estimated Annual Water Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	MMBtu	kgal	$	Years
No/Low Cost Recommendations								
1	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators Details: Install 0.5 GPM Aerators	$623	382	0	38	48	$426	1.46
Totals for No/Low Cost Items		**$623**	**382**	**0**	**38**	**48**	**$426**	**1.46**
Capital Cost Recommendations								
1	Replace Existing Hot Water Heater With New Energy Efficient Water Heater Details: Repalce Old Gas Fired Water Heater	$11,689	973	0	97	0	$1,086	10.77
2	Replace Existing Air Conditioners with Energy Star Air Conditioners Details: Replace older Rooftop Condensing Units	$16,390	0	18,221	62	0	$3,397	4.82
3	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Exterior Wall Packs, Blue and Green Gymnasium	$18,086	0	31,851	109	0	$6,118	2.96

List of Recommended Energy Conservation Measures For Pollard Middle School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Total Annual Energy Savings	Estimated Annual Water Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	MMBtu	kgal	$	Years
Capital Cost Recommendations								
4	Install Tandem Lighting System In Hallways Details: Throughout The Hallways	$18,176	0	44,962	153	0	$8,383	2.17
5	Delamp Fixtures In Individual Rooms And Install Lighting Controls Details: All Classrooms, Offices And Media Centers	$85,364	0	40,379	138	0	$7,528	11.34
6	Replace Inefficient Heating Plant Details: Replace the Existing Boiler plant with three (3) Condensing Boilers	$366,493	20,845	0	2,085	0	$23,967	15.29
Total For Capital Cost		**$516,199**	**21,818**	**135,413**	**2,644**	**0**	**$50,479**	**10.23**
	Interactive Savings Discount @ 10%		-2,220	-13,541	-268	-5	-$5,091	
	Total Contingency Expenses @15%	$77,523						
Total for Improvements		**$594,345**	**19,980**	**121,872**	**2,414**	**43**	**$45,815**	**12.97**

Detailed List of Measures Evaluated For Consideration For Pollard Middle School								
ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Estimated Total Annual Energy Savings	Annual Water Savings	Total Estimated Annual Cost Savings	Payback
		$	Natural Gas	Electricity	MMBtu	kgal	$	Years
1	Replace Existing Motors With High Efficiency Motors Details: HV-1, 2 and Cluster AHU	$3,023	0	514	2	0	$101	30.03
2	Install On-Demand Ventilation on Air Handlers Details: AHU Serving Rm. 220,222,224,212,216, AHU-6, Green Gym And Cafeteria	$8,162	14	228	2	0	$62	$132
3	Install Variable Frequency Drives (VFD) Details: Install VFD's on Front Boiler Room Pumps	$42,069	0	13,221	45	0	$2,465	$17
Total for Improvements		**$53,255**	**14**	**13,964**		**0**	**$2,627**	**20.27**

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

The facility is typically occupied from 6:30 AM until 11:30 PM. The chief custodian of the facility is the first person to open the facility whereas the cleaning crews are the last members to leave the facility. The Pollard Middle School has a total student population of 829 students that attend the 8th and the 9th grade classes. The total student count for the elementary school that occupies the portables is unknown.

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday	8 Hrs	14 Hrs
Saturday	0 Hrs	0 Hrs
Sunday	0 Hrs	0 Hrs

5.2. BUILDING ENVELOPE

The building envelope consists of the exterior shell, made up of the walls, windows, roof, and floor. The envelope provides building integrity and separates the exterior from the interior conditioned space.

According to the structural drawings, the foundations consist of a conventional, reinforced concrete, slab-on-grade foundation. The building has structural steel columns supporting the upper floor and roof. The upper floor has concrete-topped metal decks and is supported by steel beams. The exterior walls are finished with a brick masonry veneer and consists of CMU, vapor barrier and batt insulation in the order of R-19.

The primary roofs are classified as flat. The roof has been recently replaced in the summer of 2011. The existing roof is a mineral-surfaced cap sheet over a multi-ply bituminous built-up membrane type of roof. Based on the engineering drawing s and the documents made available it was determined that the roof has an average R-value of R-25.

The window consists of double pane-metal framed, thermally broken windows. No damage was observed on any of the windows.

Item	Construction Type
Foundation	Slab on Grade
Structure	Block with Steel Substructure and Concrete Decks
Exterior Walls	Brick veneer and metal panel system with 1.5"rightd insulation
Roof	3 Ply Built-Up flat roof along with sloped roof consisting of asphalt shingles.

The following table describes the observed or reported insulation levels at the property:

Building Element	Observed R-values
Roof // Attic	R – 25
Floors	R - 5
Exterior Walls Above Grade	R - 15

5.3. BUILDING HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

The pollard Middle School located in Needham, MA has high heating hours that cooling hours. The school is centrally heated by means of forced hot water heating system in conjunction with a series of unit ventilators, air handling units and fan coil units. The school doesn't have central cooling system, but has individual roof-mounted split system serving individual zones. The HVAC controls are partly pneumatic and partly DDC. The township staff is working on an ongoing project to convert all the existing pneumatic valves to DDC valves. It is estimated that approximately 1/3rd of the total valves are converted to DDC while the rest are still pneumatic. The HVAC systems along with the exhaust fans in the building are controlled by a central energy management system.

Heating System:

The central heating system consists of a total of four H.B Smith hot water boilers, hot water circulation pumps, AHU, FCU's and unit ventilators. The existing heating setup was installed in 1992. The middle school has two boiler rooms that are designated as front and back boiler room. The front boiler room consists of two HB Smith 2B-14Series cast iron hot water boilers. Both the boilers are rated at 4,258MBH I/P capacity and 2,930MBH Net IBR Output capacity. The boilers are designated as dual fuel boilers and used No.2 oil during the winter of 2010-11 due to issues with excessive noise from the main natural gas meter. The hot water is circulated around the building by two Magnetek built 15Hp premium efficiency pumps that are programmed to run in lead-lag configuration. Both the pumps have been installed in 1992.

The current energy management system is programmed to fire up the boilers once the outside air temperature falls below 60F. Further both the boilers are programmed to come on once the OA temperature falls below 10F. Currently the front boiler room takes up the entire building heating load and has been running without any issues.

The back boiler room consists of two HB Smith 28A-9 Series cast iron boilers along with two new Baldor Super-E type 25Hp hot water circulation pumps. The back boiler is used as 100% back up. Currently the hot water piping system is set up in such a way that when both hot water pumps run, they run against each other developing pressure beyond design capacity. This causes the valves to malfunction. EMG recommends that the pumping set up needs to be corrected to resolve this issue.

Currently none of the circulation pumps is equipped with variable frequency drives, thus they tend to operate at full load all throughout the heating season.

Cooling System:

The school building is not centrally cooled, but has approximately twenty six roof top split air-conditioning systems. Most of the units have already surpassed its ASHRAE recommended useful life of 15 years. The system consists of varying capacity ranging from 1 ton to 7.5 tons. The air-conditioning system is monitored by the energy management system in a manner that the air-conditioning do not come on until the OA temperature rises above 60F and the indoor temperature rises above 75F. This thus limits the actual hours of operation of the air conditioner thus reducing the energy consumption by the school. All the air conditioners have localized controls.

Ventilation and Exhaust Systems:

The Pollard Middle School is ventilated by a total of 57 exhaust fans that serve various restrooms, kitchen, classroom spaces and auditoriums. Currently all the exhaust fans are tied into the building management system by virtue of which their operational hours are limited to 6:00 AM to 5:00PM Monday to Friday during the normal school operations. The exhaust fans are shut off on all other days. Based on the interaction with the HVAC supervisor, the exhaust fans are routinely checked and replaced if necessary.

The auditorium in the Pollard Middle School is conditioned by two Air Handling Units. The primary AHU that supplies conditioned air to the Auditorium has a spiral duct based distribution system right above the stage. The very design of the spiral duct makes the air distribution system noisy in nature, thus making it imperfect for an auditorium environment. In addition to this primary AHU, the fresh air supply for the auditorium is also maintained by a secondary AHU that is purely controlled by the CO_2 sensor in the space. Once the CO_2 in the space rises over the prescribed limits, the second AHU starts supplying 100% outside air via a separate duct work, which is relatively quite as compared to the spiral ducts. Thus in order to maintain lower noise levels from the air distribution system the HVAC operators turn of the primary AHU and conditioned the auditorium by the secondary AHU only. This leads to 100% outside air irrespective of the occupancy level in the auditorium and increased heating load on the boiler. EMG recommends modifying the ductwork in the auditorium so that the noise levels are reduced to the accepted levels and allowing the primary AHU to take up the load of the auditorium in place of the secondary AHU.

The fresh air requirement for the rest of the Pollard school is satisfied by a series of AHU's and unit ventilators located in individual spaces. Most of the AHU's are currently bringing in 100% outside air all day long, irrespective of the space occupancy. EMG recommends installing CO_2 sensors on each of the air handling units so as to control the amount of fresh air being brought into the conditioned space.

Following are the AHU's that need to be retrofitted with CO_2 sensors:

Air Handling Unit Name	Location it Serves
Room. 220	Requires CO_2 Sensor
Room. 222	Requires CO_2 Sensor
Room. 224	Requires CO_2 Sensor
Cafeteria	Requires CO_2 Sensor
Room. 212	Requires CO_2 Sensor
Room. 216	Requires CO_2 Sensor
AHU-6 (Faculty Dining Rm.)	Requires CO_2 Sensor

Air Handling Unit Name	Location it Serves
Green Gym	Requires CO_2 Sensor

Item	Measured Values
Major Heating system type/capacity	Two each of 4258MBH and 2836MBH IBR Rated H.B Smith Boilers
Major Cooling System type/capacity	Numerous split systems
Heating hot water supply temperature	Polyshield Gas-fired Hot Water Heater. 140F supply
Chilled water supply/return temperatures	NA
Condenser water supply/return temperatures	NA
Outside Air temperature & Relative Humidity (%) at time of audit	62F and 45.2% R.H
Interior space temperatures & Relative Humidity (RH %)	Varied From Space to space, but averaged at 76F and 48% R.H
Avg. Interior space thermostat set-point	69F For Heating and 75F For Cooling

The Mechanical Equipment Schedule in Appendix contains a summary of the HVAC Equipment at the property.

5.4. BUILDING LIGHTING

The building lighting at the Pollard school mainly consists of standard 4' long 32W T8 lamps in various configuration ranging from single bulb per fixture to four bulbs per fixture. The general lighting in the space is on the higher side of the recommended levels. EMG has observed numerous opportunities across the school where energy consumption can be reduced by modifying the current lighting pattern and reducing the light levels in the hallways and classrooms by reducing the number of lamps per fixture. Further it was also observed that none of the spaces other than the restrooms on the second floor and the portables had automatic lighting controls. This leads to the lights in the spaces being left ON for long durations without anyone being present in the space.

The lights in the gymnasium consist of 400W MH lamps that are operational from 6:30AM till 11:30PM throughout the school year. The cafeteria and first floor hallway consists of two lamp U shaped T8 lamps that are left ON from 6:30AM until 11:30PM.

The site lighting consists of 75W and 175W external wall packs. All the external lights are controlled by an electronic timer.

Space Type	Measured Light Levels (Lux)
Rm. 272	540 Lux
School Office Lobby	628 Lux
Book Keeper	1000 Lux
Green Gym	300 Lux
Hallways	600 Lux
Avg. Building Lighting Density, W/Sq.Ft	0.824 Watt/Sqft

Note: 1 foot candle = 10.764 lux

The Lighting Systems Schedules in Appendix contain a summary of the Existing Lighting Systems at the property, along with proposed Lighting Energy Conservation Measures.

5.5. BUILDING ELEVATORS AND CONVEYING SYSTEMS

The Pollard School has two hydraulic elevators, one manufactured by Dover and rated at 2500lbs and a speed of 100FPM. The second hydraulic passenger elevator is manufactured by Bakewith and is rated at 1500lbs.

5.6. BUILDING DOMESTIC HOT WATER

The domestic hot water requirement for the facility is satisfied by a single 125-gallon, 800 MBH gas-fired hot water. The hot water heater of Polyshield make was installed in 1992 and has surpassed its effective useful life period and is up for replacement. The hot water heater is set to deliver hot water at 140F, so that the kitchen receives water at 140F, the janitor's closet receives water at 130F and the restrooms receive water at 120F via the mixing valves.

The water meter is located in the front mechanical room.

The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The toilets consist of flush valves. The typical flush volume was 1.6 GPF. The lavatories are equipped with aerators rated at 1.5 GPM. The lavatories are operated by manual controls. The shower heads have a rated capacity of 2.2 GPM.

DHW type	Gas-fired
Storage Tank Capacity	NA
Heating/tank set-point	140F

DHW temperature at faucet	120F
Building faucets, GPM	1.5GPM
Water closets/toilets, GPF	1.6 GPF

5.7. BUILDING NATURAL GAS AND ELECTRICITY

Natural Gas

The building is connected to the natural gas utility (Nstar). The gas main on the adjacent public street supplies the natural gas service. The gas meter and regulators are located in outside the mechanical room housing the main boilers. The gas distribution piping within the building is malleable steel (black iron). The facility is master-metered for natural gas.

Electricity

The electrical supply lines run underground pole-mounted transformer to an interior-mounted electrical meter. The main electrical service size is 2000 amps, 120-volt, three-phase, four-wire alternating current (AC). A step-down transformer is located in the main electrical room. The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building. The facility is master-metered for electricity.

The portables at the back of the school are equipped with its own individual electrical meter.

No. 2 Oil:

The hot water boilers in the school are dual fuel boilers, by virtue of which they can switch to No.2 Oil fuel as needed.

Emergency Generator:

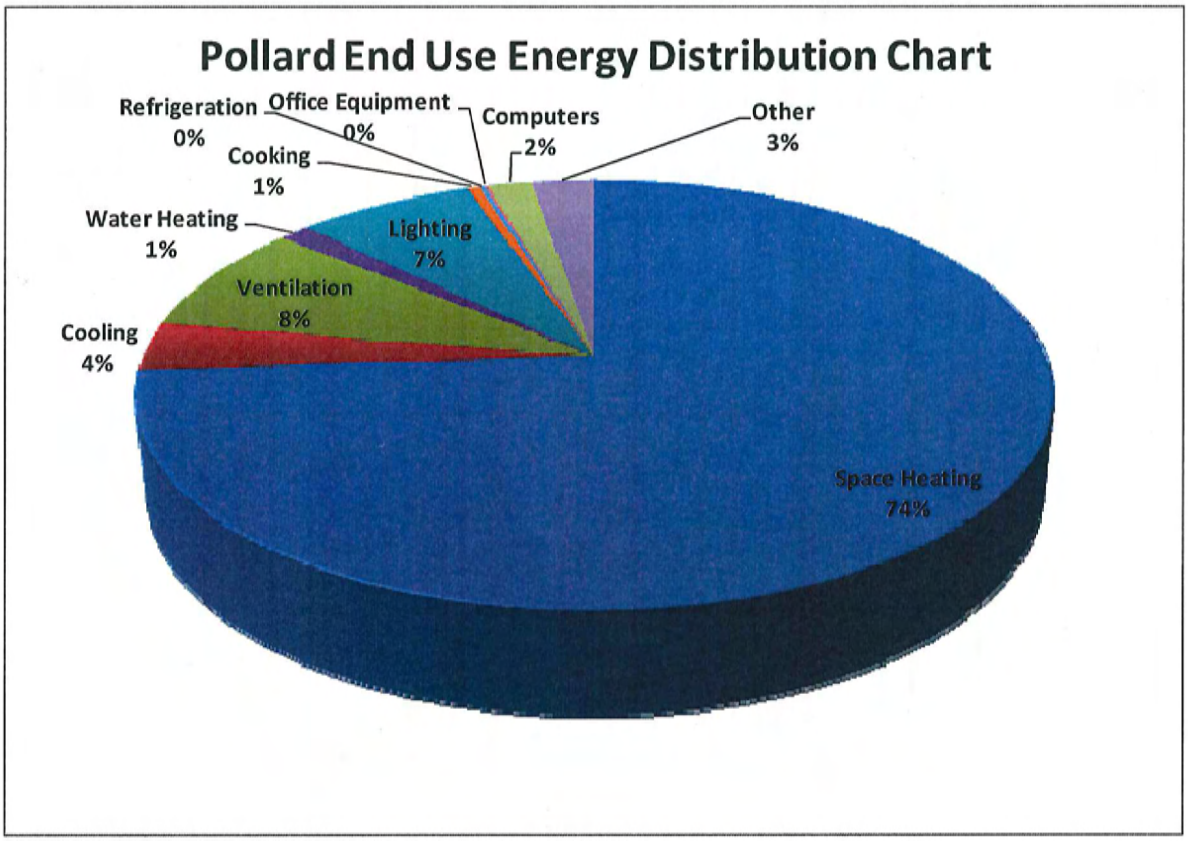
A diesel-engine-driven 125kVA emergency electrical generator is located in the front mechanical room. The generator provides back-up power for elements of the fire and life safety systems. The fuel tank is an underground tank, which is located adjacent to the school.

Electrical Transformer Type (Wye, Delta)	Delta
Mounting	Pole-mounted
Location	Exterior
Main Building Electric service	2000 Amps
Primary Volts	120V
Secondary Volts	NA
Phase	3 Phase
Wire	4 Wire
Amp	2000 Amps
On site Generator (Y/N)	Yes
Generator Capacity, KVA	125 KVA
Generator Fuel Type	Diesel

Electric Meter type (Master/Sub/Direct)	Direct	Natural Gas Meter type (Master/Sub/Direct)	Direct
Meter Location	Exterior	Meter Location	Exterior
Main meter number	NA	Main meter number	NA

7. END USE ENERGY DISTRIBUTION

Components of Annual Energy Use																	
	Electricity (1 kWh = 3.412 kBtu)				Natural Gas				Total Cost		No.-2 Oil				Total Energy	
	%	kWh	kBtu	Cost	%	therms	kBtu	Cost	Total- $	% Total	%	Gallons	kBtu	Cost	MBtu	% Total
Space Heating	6.0%	49,721	169,647	$9,270.02	81.0%	6,107	610,415	6,814	$16,084	9.9%	100.0%	51,998	7,201,706	$135,142	7981.8	74.0%
Cooling	13.6%	112,700	384,534	$21,012.04			0	0	$21,012	12.9%	0.0%	0	0	$0	384.5	3.6%
Ventilation	32.0%	265,178	904,786	$49,440.10			0	0	$49,440	30.3%	0.0%	0	0	$0	904.8	8.4%
Water Heating	0.0%	8	28	$1.55	19.0%	1,432	143,184	1,598	$1,600	1.0%	0.0%	0	0	$0	143.2	1.3%
Lighting	28.0%	232,030	791,688	$43,260.08			0	0	$43,260	26.5%	0.0%	0	0	$0	791.7	7.3%
Cooking	2.0%	16,574	56,549	$3,090.01	0.0%	0	0	0	$3,090	1.9%	0.0%	0	0	$0	56.5	0.5%
Refrigeration	1.0%	8,287	28,275	$1,545.00			0	0	$1,545	0.9%	0.0%	0	0	$0	28.3	0.3%
Office Equipment	0.4%	3,480	11,875	$648.90			0	0	$649	0.4%	0.0%	0	0	$0	11.9	0.1%
Computers	7.0%	58,008	197,922	$10,815.02			0	0	$10,815	6.6%	0.0%	0	0	$0	197.9	1.8%
Other	10.0%	82,868	282,746	$15,450.03			0	0	$15,450	9.5%	0.0%	0	0	$0	282.7	2.6%
Total	100.0%	828,854	2,828,050	$154,532.7	100.0%	7,539	753,598	8,412	$162,945	100.0%	100.0%	51,998	7,201,706	135,142	10783.4	100.0%


Pollard End Use Energy Distribution Chart
Refrigeration 0%
Office Equipment 0%
Computers 2%
Other 3%
Cooking 1%
Water Heating 1%
Lighting 7%
Ventilation 8%
Cooling 4%
Space Heating 74%

8.3.1. Repalce Domestic Hot Water Heater With New High Efficiency Hot Water Heater

The domestic hot water requirement for the Pollard School is satisfied by a single 125-gallon 800MBH input gas-fired hot water heater. The existing hot water heater was installed in 1992 and has already outlived its useful life. Based on the manufacturer specification, a new water heater is rated at 83% efficiency. Thus based on the age and use of the hot water heater it is assumed that the existing thermal efficiency of the hot water heater has dropped to about 75%.

The hot water heater design has evolved over the time and new high efficiency condensing hot water heaters are currently available in the market that have a manufacturer rated efficiency in excess of 95%. This would provide an increase of 20% over the existing domestic hot water efficiency.

The proposed replacement is estimated to save up to 973 therms per year.

8.3.2. Replace old Air Conditioners With New Energy Star Certified Airconditioners

Advances in compressor and condenser technology have allowed for the development of more efficient air-conditioning systems. As a result cooling can be provided at the same rate, with a lower energy input. Energy efficiency ratio (EER) is the ratio of cooling output to power input. Seasonal energy efficiency ratio (SEER) is an adjusted figure based on the length of the cooling season. A higher EER or SEER indicates a more efficient unit which can provide the same cooling capacity while consuming less energy. The minimum standard for air conditioner performance in most areas is currently 13 SEER as required by the 2006 International Energy Conservation Code. Units rated at 16 SEER (14 EER) or better qualify for Energy Star certification.

Pollard school has number of roof top split systems that were installed in 1993-95. All of these units have outlives their expected useful life and it is recommended that these units be replaced with new high efficiency air conditioners. The table below provides the details of the air conditioners that need to be replaced.

Table-1					
Manufacturer	**Year**	**Location**	**Model No.**	**Tonnage**	**Serves**
TRANE	1993	Rooftop	TTRO12C100	1 Ton	Secretary's Office
TRANE	1993	Rooftop	TTRO12C100	1 Ton	Admins Office
TRANE	1993	Rooftop	TTR012C1	1 Ton	A/C Nurse
TRANE	1995	Rooftop	TTR024C100A1	2 Ton	Rm 258
Table-2					
Manufacturer	**Year**	**Location**	**Model No.**	**Tonnage**	**Serves**
TRANE	1995	Rooftop	TTR036C100	3 Ton	Rm 278
TRANE XE 1000	1995	Rooftop	TTR024C100A1	2 Ton	Rm 200
TRANE	1995	Rooftop	TTA048C300	4 Ton	Rm 210
TRANE	1995	Rooftop	TTA048C300	2 Ton	Rm 220
TRANE	1995	Rooftop	TTA048C300	2 Ton	Rm.224

Currently most of the classrooms and offices have four lamp T8 fixtures with single ballast. The average light levels taken in these spaces showed that the Lux readings where often on the higher side of the recommended range that extends from 300 LUX to 60 LUX. EMG recommends that all the four lamp light fixtures be retrofitted with reflectors and be de-lamped from four lamp per fixture to two lamp per fixture.

In addition to delamping the four lamp fixtures to two lamp fixtures, EMG also recommends installing occupancy sensors in each of the classroom and office space so as to ensure that the lights are turned off once the sensor detects no occupancy for more than a prescribed duration of time.

Based on the detailed site survey it is determined that approximately 395 four lamp fixtures need to be delamped to two lamp fixtures along with installation of 105 ceiling-mounted occupancy sensors.

In addition to the classrooms the central cafeteria is also lit by a set of fifty, three lamp U shaped lamps that are left ON all throughout the school day. Lights were observed to be ON irrespective of the occupancy in the space. Thus EMG recommends installing ceiling-mounted occupancy sensors in the cafeteria that would turn off the lights in individual spaces once it detects that the space is unoccupied for a pre-programmed duration of time.
It should be noted that when installing occupancy sensor all the electronic instant start ballast be replaced with rapid start ballasts. It is assumed that all the existing light fixtures are equipped with electronic instant start ballast and hence this ECM takes into consideration the cost for replacing all the ballasts with new rapid start ballasts.

EMG considers upgrading the lighting in the school building as a major capital expenditure from which the school will continue to profit for many years to come. Thus, even though the ECM fails the SIR test, EMS still recommends delamping all lamp fixtures and installing occupancy sensors in individual spaces.

8.3.6. Install Condesning natural gas fired hot water boilers

EMG recommends replacing the current cast iron sectional hot water boilers with about 68.8% manufacturer rated efficiency with 94% efficient natural gas fired condensing hot water boilers. For improved part load performance, we recommend total of three (3) condensing boilers to replace the two cast iron boilers. The condensing boilers will be equipped with outside air reset controls. The savings and avoided maintenance cost justifies such replacement.

8.4. ECMs Evaluated For Consideration

EMG has identified 3 Energy Conservation Measures (ECMs) which were evaluated for this property but not recommended based on financial criteria. EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

The following paragraphs describe each of these ECMs along with the initial installed cost, annual energy savings and payback period for each ECM.

8.4.1. Replace Inefficient Fan Motors in The Air Handling Units With High Efficiency Units

High-efficiency motors will perform the same function as standard motors, but will improve efficiency by reducing losses in the conversion of electrical to mechanical energy. For example, magnetic losses are reduced by using thinner, higher quality steel lamination in the stator and rotor core. The air gap between rotor and stator is minimized by manufacturing to higher tolerances. More copper is used in the stator windings to reduce resistive losses. On motors with fans, smaller and more efficient fans are used.

The best applications are generally those in which the motor operates at least eight hours or more per day (NCEL 1983a). In some cases, the savings in electrical energy consumption justifies immediate replacement.

However, high-efficiency motors are not cost-effective when their premium cost cannot be recovered during the normal life of the motor because of limited hours of operation.

EMG recommends replacing motors in the following Air Handling Units:

AHU's	Motor (HP)	Existing (%)	Proposed (%)
HV-1 (220 Days/yr)	5 Hp	86.5%	90.2%
HV-2 (180 Days/Yr)	5 Hp	86.5%	90.2%
Cluster-1 (180 Days/Yr)	5 Hp	89.5%	92.4%

8.4.2. Install On-Demand Sensors in Air Handling Units

Some buildings are ventilated at a rate in excess of the recommended values. To reduce the energy consumed by the ventilation system, the ventilation rates should be lowered, unless typically high levels of pollutants are being generated. (If human carcinogens or other harmful contaminants are suspected to be present in the occupied space, other relevant standards or guidelines, such as OSHA or NIH, must supersede the listed values.) For spaces with transient or variable occupancy, the quantity of outdoor air should be adjusted by use of dampers, multi-speed ventilation fans, or by duty cycling the system. When contaminants independent of the occupants are generated in the space, the supply of outdoor air should lead occupancy so that acceptable conditions are attained before occupants return. On the other hand, if contaminants are generated solely by the occupants, the supply of outdoor air may lag occupancy. Such control over the ventilation rate can be achieved by installing on demand ventilation system on air-handling units that senses the amount of carbon dioxide in the return air and modulates the external air flow based on it. In case the CO_2 levels are low, which means the occupancy level in the facility is below normal, hence there doesn't exist, a need to bring in fresh air. This indirectly reduces the load on the air handling unit as it decreases the amount of energy required to condition the outside air.

Conversely on detecting a high level of pollutants and carbon dioxide residue in the return air, the sensor shall modulate to increase the intake of outside air, for compensating the impure air.

EMG recommends installing CO2 sensors on each of the air handling units that have in built economizers so as to control the quantity of outside air being brought into the space. The following table provides the list of air handling units that require to be retrofitted with CO2 sensors.

Air Handling Unit Name
Room. 220
Room. 222
Room. 224
Cafeteria
Room. 212
Room. 216
AHU-6 (Faculty Dining Rm.)
Green Gym

8.4.3. Install Variable Frequency Drives on main Hot Water Circulation Pumps

The Pollard middle school is currently heated by four central forced hot water boilers located in two separate boiler rooms. The hot water from the boilers is circulated around the building by two 15 Hp and two 25Hp circulation pumps.

EMG recommends installing VFD on primary hot water circulation pumps for improved part load operation.

10. APPENDICES

APPENDIX A: Photographic Record (selected pages)
APPENDIX B: Thermal Photographic Record
APPENDIX C: Site Plan (selected pages)
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APPENDIX A:
PHOTOGRAPHIC RECORD

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-006.268 **Project Name: Pollard Middle School**

Photo #13:	Main electric meter

Photo #14:	Main gas meter

Photo #15:	Main domestic water meter

Photo #16:	Natural gas-fired hot water boilers in the front boiler room

Photo #17:	Main hot water circulation pumps

Photo #18:	No.2 oil pumps for the boiler

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-006.268 **Project Name: Pollard Middle School**

Photo #19:	Mechanical Room 1 (has 3x AHU)

Photo #20:	Hot water boilers in Boiler Room 2

Photo #21:	Hot water circulation pumps in Boiler Room 2

Photo #22:	Packages RTU's serving the portables

Photo #23:	Roof top split systems servings individual spaces

Photo #24:	New flat roof and skylights

APPENDIX F:
MECHANICAL EQUIPMENT INVENTORY

Mechanical Equipment Inventory- Pollard Middle School							
Equipment	Manufacturer	Year Installed	Location	Model/Type	Capacity	Serves	Remarks
Boilers (2x)	Smith	1992	Front Boiler Rm.	2B-14	4,258MBH	Whole School	Old But Works Well
HWP (2x)	Magnetek	1992	Front Boiler Rm.	Catg. R416	15Hp	Whole School	Old But Works Well
Domestic Hot Wate Heater	Polyshield	1992	Front Boiler Rm.	1000P125A-TP	800MBH	Whole School	Works Well
Main Generator	Kohler	1992	Front Boiler Rm.	100R07231	125kVA,100kW	Emergency Fixtures	Old But Works Well
Pneumatic Air Comprressor	Curtis	1992	Front Boiler Rm.	3kW31G	2x(1.5Hp Motors)	Whole School	Old But Works Well
AHU-6	TRANE	1992	Mech Rm-1	k95k79443	1 HP fan motor	Faculty Dining	Pneumatic Controls
HV-2	TRANE	1992	Mech Rm-1	E223	5Hp Fan	Kitchn	86.5% Effi Motors
HV-2	TRANE	1992	Mech Rm-1	E223	5Hp Fan	Locker Rm	86.5% Effi Motors
Boilers (2x)	Smith	1992	Back Boiler Rm.	28A-9	1941MBH	Whole School	Not Used Much
HWP (2x)	Baldor	1992	Back Boiler Rm.	EM2531T-8	25Hp	Whole School	Never Used
Elevator-1	Beckwith	NA	New Construction	NA	1500Lbs	School	Old But Works Well
Elevator-2	Dover	1992	New Construction	EP-60-20	2500 Lbs	School	Works Well
AHU	TRANE	1992	Art Room	k95k79554	2Hp Motors	Art Room	Works Well
AHU	TRANE	1992	Rm 222	k95k79554	2Hp Motors	Wood Work	Works Well
AHU	TRANE	1992	Rm224	k95k79554	2Hp Motors	Art Room	Works Well
AHU	TRANE	1992	Auditorium	NA	NA	Auditorium	Meant to supply Outside Air
AHU	TRANE	1992	Auditorium	NA	NA	Auditorium	Meant to circulate air with heating coils
AHU	Magic Aire	1994	Rm 221	60-BVMBUX-A	NA	Rm 221&219	Works Well
AHU	TRANE	1995	Cluster-1	K95K80211	NA	Cluster Rm	Works Well
AHU	TRANE	1992	Cafeteria	MCCA014	7.5HP	Cafeteria	Works Well